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FROM : [redacted] 25X1

SUBJECT: Trip Report - [redacted]

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1. [redacted] was visited on 15 and 16 February 1961 [redacted] and on 16 and 17 February 1961 [redacted] to monitor progress on Contract 605, Task Orders 8, 9, 11, and 12 [redacted] and 10 [redacted] Present for discussions and demonstrations were: 25X1 25X1 25X1 25X1

[redacted] 25X1 25X1

2. Under Task Order 8, a system of antennas, detectors, and filters is being developed for ELINT activity in the 50 mc to 40 kmc frequency range. Task Order 8 has been extended to 14 April to allow time for optimizing design of the stripline filters and to allow time for a redesign of the throat-loaded 10 to 40 kmc horn-filter system. Additional effort has been directed toward producing filters that can be economically reproduced using production line techniques, and it has developed that the extremely close mechanical tolerances heretofore deemed essential can be relaxed with no deterioration in performance. The throat-loaded horn to cover the 10 - 40 kmc range has been redesigned to eliminate pattern degradation which occurred at approximately 35 kmc using the old system of inserting a slab of very high dielectric constant material into the throat of the horn. The new design uses a larger connecting waveguide which has a metal sleeve inserted around a material of much lower dielectric constant when operating in the 30 - 40 and 20 - 40 kmc mode. For the 10 - 40 kmc mode the metal sleeve is removed and a material with relatively low dielectric constant (4.8) is inserted. The materials involved in the new design are much less fragile than the material formerly used, and therefore, pattern degradation, due to wear of the slabs of dielectric materials, should be greatly reduced.

3. Task Order 9 is a development and production contract for five 1 - 10 kmc LP Antenna Dish Feeds, AN-47. These antennas have been received at the warehouse and are going into stock.

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4. Task Order 11 is a production contract for items developed under Task Order 8. Components are being fabricated as the design becomes firm, however, this task will necessarily have to be extended since the delivery date is contingent upon completion of Task Order 8.

5. Task Order 12 is a production contract for three CS-8 type antennas less outdoor mounts. The antennas have been received at the warehouse but are being held in receiving because of missing parts. The contractor was notified of the discrepancy and has promised prompt attention. A method of remotely rotating this type of antenna was discussed with the contractor and a proposal solicited for production of five units.

6. Task Order 10 is a study program directed toward the use of unconventional antennas, especially items normally found in a household or hotel room. The initial approach to the problem was first to develop a tuner capable of matching the wide range of impedances encountered and then investigate the radiating characteristics of the various structures and their preferred feed points. A composite tuner, bridge, and wideband noise generator has been incorporated into a tuning system capable of meeting the test requirements. (See Attachments 1 and 2).

7. To demonstrate the matching technique and some unusual radiators the contractor matched the output of a [redacted] 100 watt transmitter 25X1
to the silvered back of a 5' x 1½' mirror, a piano frame and strings, a metal coat rack, and a metal chair on 7.1 and 14.3 mc and communicated with a ham operator at Pamona, California from [redacted] The contractor 25X1
also stated that the tuning system could be packaged in a case approximately 5" x 4" x 1½".

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Attachments:
1) June Moon Progress Report No. 5
2) June Moon Progress Report No. 6

Distribution:
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JUNE MOON PROJECT

Monthly Progress Report No. 5 — Period Ending 1 January 1961

Design of a test tuner to be used in evaluating short radiating structures and their preferred feed points is complete, and this unit is now being fabricated. The three-element, reactive, pi-section network design which was used is a logical choice for the antenna tuner since it is economical in the number of components, capable of handling an extremely wide range of impedance, allows close control of the loaded Q, and contributes to harmonic suppression when the shunt arm on the input side is capacitive.[1] The following design equations give the circuit values of the nondissipative pi-network of figure 1 for matching an antenna impedance (Z_A) to a resistive impedance Rp.

1) $$X_1 = -\frac{R_p}{Q_L}$$

2) $$X_2 = -\left[X_1 - \sqrt{R_s(R_e - R_s)}\right]$$

3) $$X_3 = \frac{R_e}{-\frac{X_A}{R_A} - \sqrt{\frac{R_e}{R_s} - 1}}$$

Where Q_L = Loaded Q

$R_s \cong \frac{R_p}{Q_L^2}$

$R_e = \frac{R_A^2 + X_A^2}{R_A}$

R_A & X_A = the resistive and reactive components of the impedance Z_A respectively

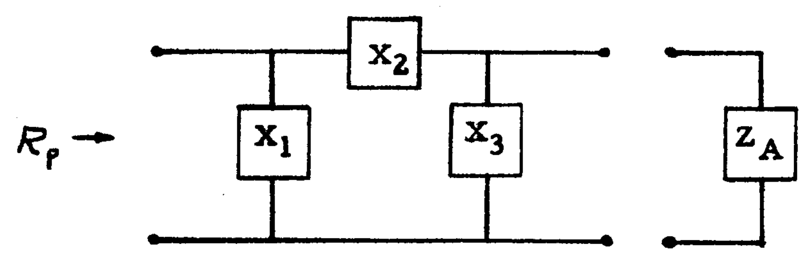

FIGURE 1

Arms 1 and 3 were restricted to capacitive values of reactance and consequently, Arm 2 was restricted to inductive values of reactance.

The range of impedances that this tuner will match can be determined by letting X_2 and X_3 vary between practical values. X_1 will have little or no effect on this range and serves only to control the loaded Q of the network.

Work this month has also been directed along the lines of reducing the size and complexity of a bridge which could easily be incorporated as part of the composite tuner (i.e., integrated in with a transceiver). The most promising circuit arrangement appears to be that of figure 2. This type of bridge, termed the hybrid-coil bridge,[(2)] would work very well with a transmitter whose output impedance is known and is fairly constant across the frequency range. It is small compared to other types of bridges, covers a wide frequency range, and requires no initial adjustments. When $Z_1 = Z_2$ in figure 2, no voltage is present across the detector terminals.

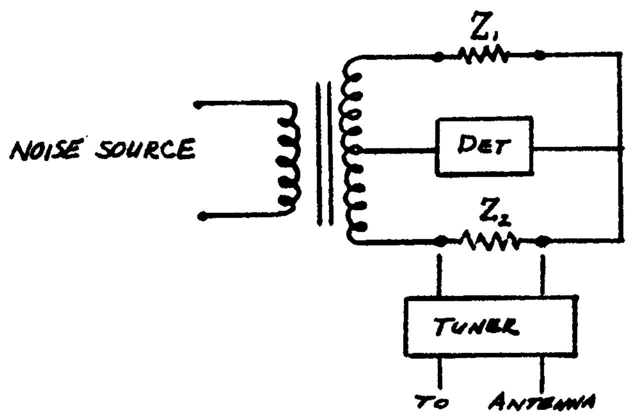

FIGURE 2

If Z_1 is the complex conjugate of the transmitter impedance and Z_2 is the impedance presented by the tuner and the antenna, then to match this transmitter to the antenna it is only necessary to adjust the tuner for a null at the detector and connect the transmitter to the tuner.

If the transmitter output impedance is not constant, a great deal of complexity is added to this bridge since Z_1 would then become a function of frequency.

A 50 ohm hybrid-coil bridge (Z_1 = 50 ohms) was built using a torroid transformer core and preliminary results indicate that its accuracy over the 3-30 Mc frequency range is excellent when used with a noise generator as the signal source. This accuracy was determined by first connecting a 1000 ohm resistor on the antenna terminals of the tuner in place of the antenna so that the null would not be broadened by atmospheric noise. The tuner, now representing a variable impedance, was adjusted for a null at the detector. The impedance at the transmitter terminals of the tuner was then measured with a GR-1606A bridge and recorded as a function of frequency. The 1000 ohm terminating resistor was then replaced by a short antenna and the procedure repeated. The following results were obtained:

Frequency in Mc	Z of tuner + resistor	Z of tuner + antenna
6	50 + j0	48 - j0.4
10	50 + j0.2	49 + j0.8
20	49 + j0	50 + j4.0
30	46 + j0	43 + j4.0

The values in column 2 represent the accuracy that can be obtained with this bridge. The less accurate results in the last column indicate that the null was broadened by antenna noise (atmospheric and man-made) but accuracy in this case is a function of the antenna and the generated noise level. These values present a mismatch less than 1.2 to 1 for a 50 ohm system.

Design of a transistorized noise generator which is small enough to be incorporated with the bridge in a composite tuner was begun the latter part of this month.

The idea of using an impedance inverter for the purpose of obtaining a resistive impedance across a given frequency range, as discussed earlier in project, shows little promise. The active elements required in this device would have to have a large power handling capability for the transmitting mode of operation and low noise figures for receiving. Although a resistive impedance can be obtained, its value might be much different from the output impedance of the transmitter, thus the use of a tuner would still be required.

Evaluation of short radiating structures will begin early in January.

References:

(1) Leo Storch, Design Procedures for Pi-Network Antenna Couplers, Proc. IRE, p. 1427, December, 1949.

(2) International Telephone & Telegraph Corporation, Reference Data for Radio Engineers, Fourth Edition, p. 268.

Prepared by:

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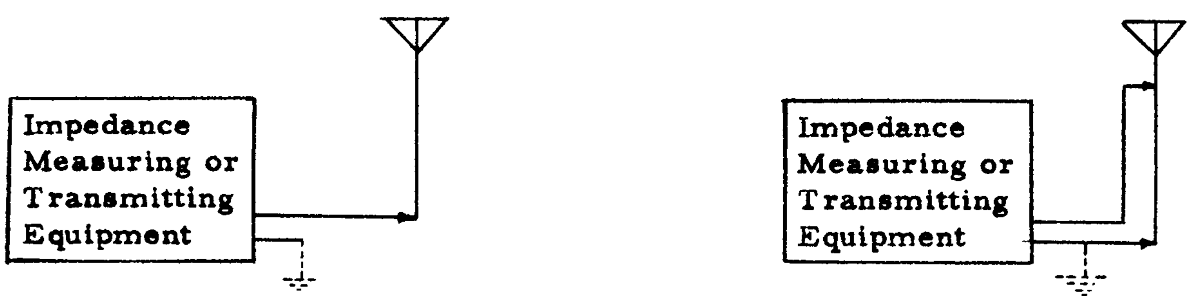
JUNE MOON PROJECT

Monthly Progress Report No. 6 Period Ending 1 February 1961

Fabrication of an interim test tuner to be used in evaluating short radiating structures and their preferred feed points was completed this month and the tuner has been partially checked out. As a preliminary check on the matching capability of this tuner a 1000 ohm and a 10 ohm resistive load were transformed to $50 + j0$ at several frequencies between 3 and 30 mc. Matches very near $50 + j0$ were also obtained when two typically high reactive short radiating structures were used as loads. Although an extensive investigation of the practical matching range of this tuner has not been undertaken, it is felt that it will be very close to what has been predicted theoretically.

Preliminary investigations of several typical short radiating structures were carried out this month and a more detailed study of the feed point and impedance characteristics of these units is now underway. Two basic methods of feeding these structures were used. The series method illustrated in Figure 1 utilizes



Series Feed Shunt Feed

FIGURE 1

only one connection to the radiating structure, while the shunt feed method uses two connections and is essentially a large loop. In either case, the equipment involved may be grounded or left floating, but in the floating arrangement, the equipment itself may become a part of the radiating structure. This latter condition is considered of interest since a ground connection is not always available. Thus, four variations in the method of feed have been employed and since the radiating structure itself may assume different positions with respect to ground, the number of possible arrangements is quite extensive. Preliminary impedance measurements on three units in a total of nine configurations revealed that the impedance of these units is well within the matching range of the tuner. These results are considered quite encouraging since the capabilities of the tuner are not particularly extensive. The smallest maximum length to wavelength ratio ($\frac{L_{max}}{\lambda}$) structure tested so far has been .0183. When RF power was applied to this structure, it loaded and from all indications it radiated well. Thus, it is expected that good success in obtaining a matched condition with other radiating structures will be realized even though the impedance of some of the smaller $\frac{L_{max}}{\lambda}$ ratio structures is affected somewhat by the position of the operator.

A transistorized noise generator, small enough to fit inside the interim tuner chassis was completed this month. This unit will be used in evaluating the bridge system of obtaining a match.

This program now stands about 30% complete. It now appears that the completion date should be extended another two or three months beyond the present

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contract expiration date to permit completion of these investigations. Such an extension would be within the program funds and no over-run in cost will be involved.

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